Maintenance of the seasonal cycle and the interannual variability by intra-seasonal stochastic variability in the equatorial Atlantic

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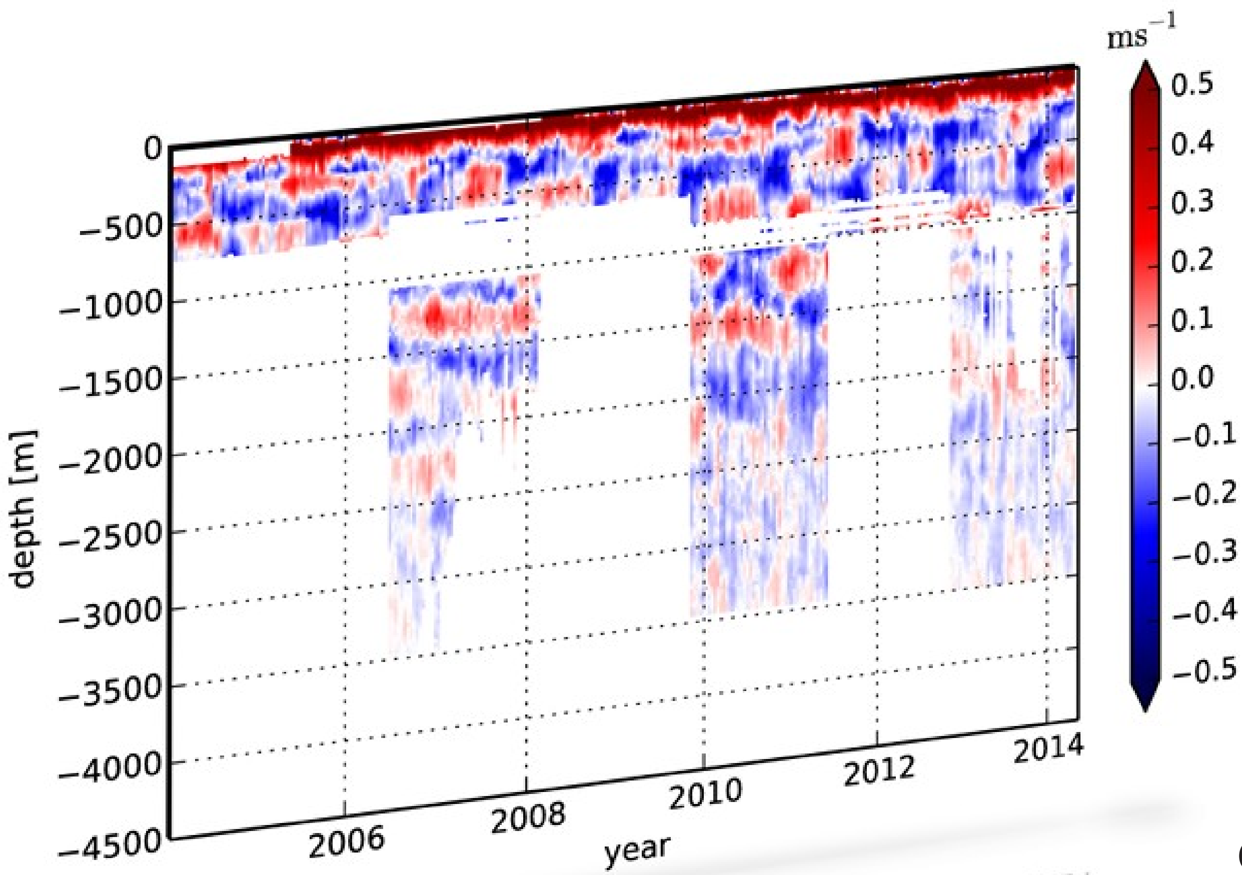

Grenoble, 21/04/2017

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Equatorial Deep Jets

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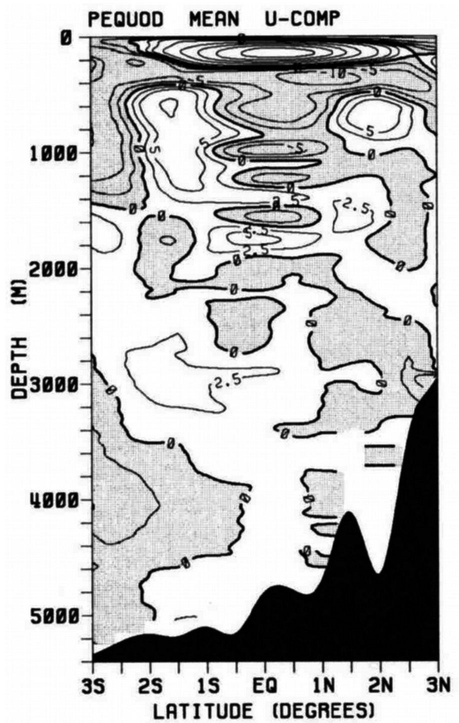
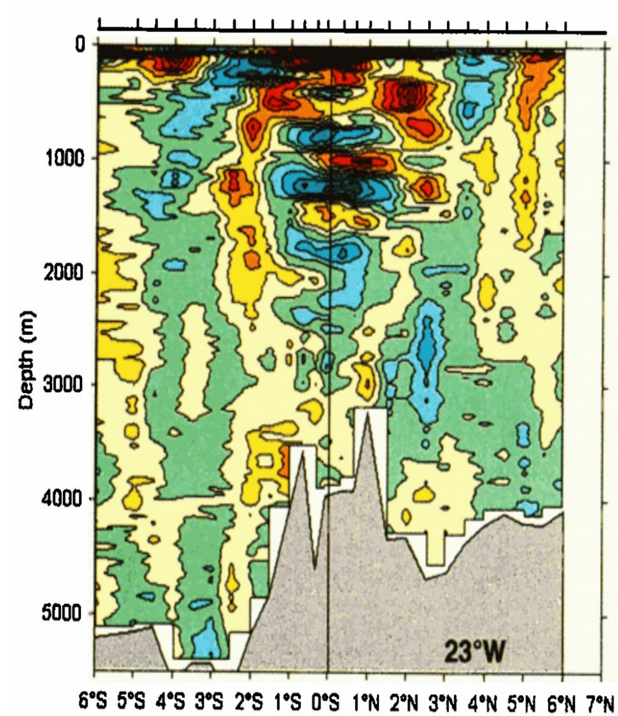
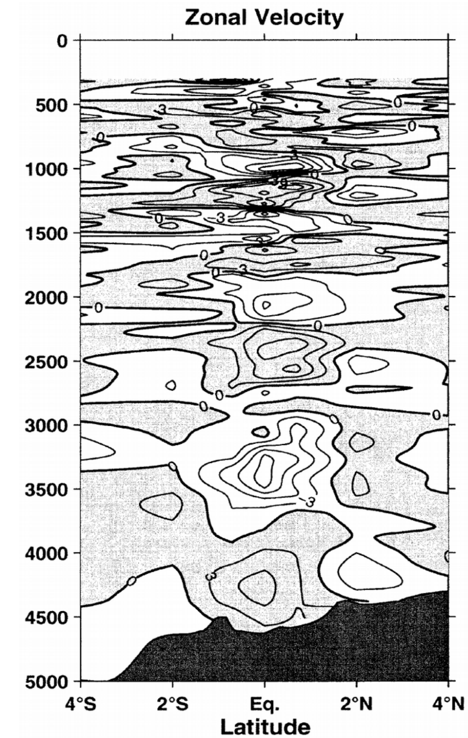
Pacific



Atlantic



Indian Ocean



Vertical Mode	8 < 22 < 39	12 < 17 < 21	8 < 19 < 41
Width	1.00°	1.08°	1.09°
λx	144°	71°	71°
Period [yr]	10 < 12 < 15	4.6 < 4.8 < 5.0	4.4 < 4.9 < 5.6

Firing et al. (1987); Gouriou et al. (2001); Dengler & Quadfasel (2002); Youngs & Johnson (2015)

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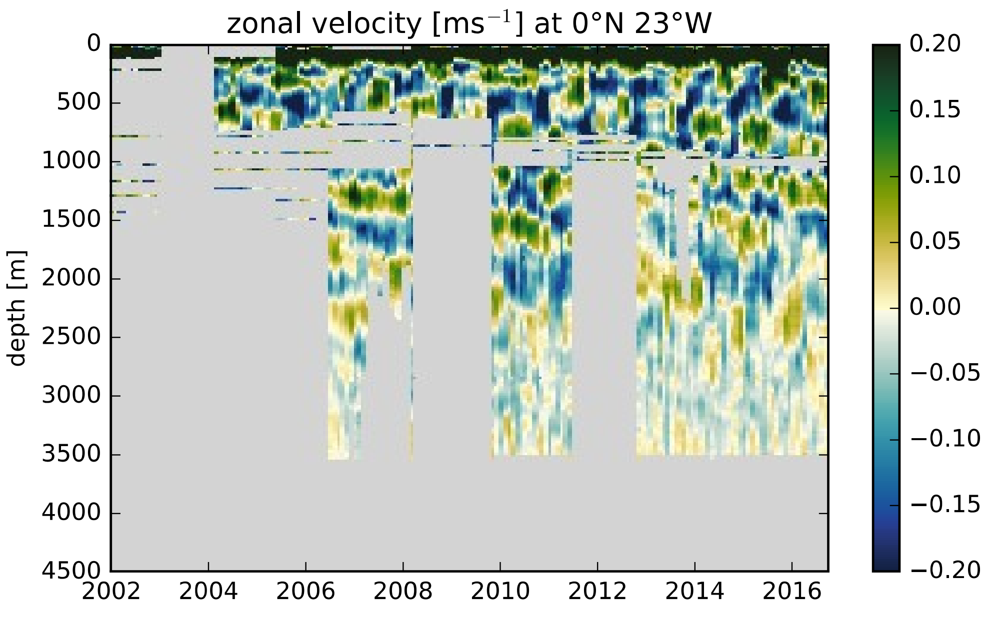
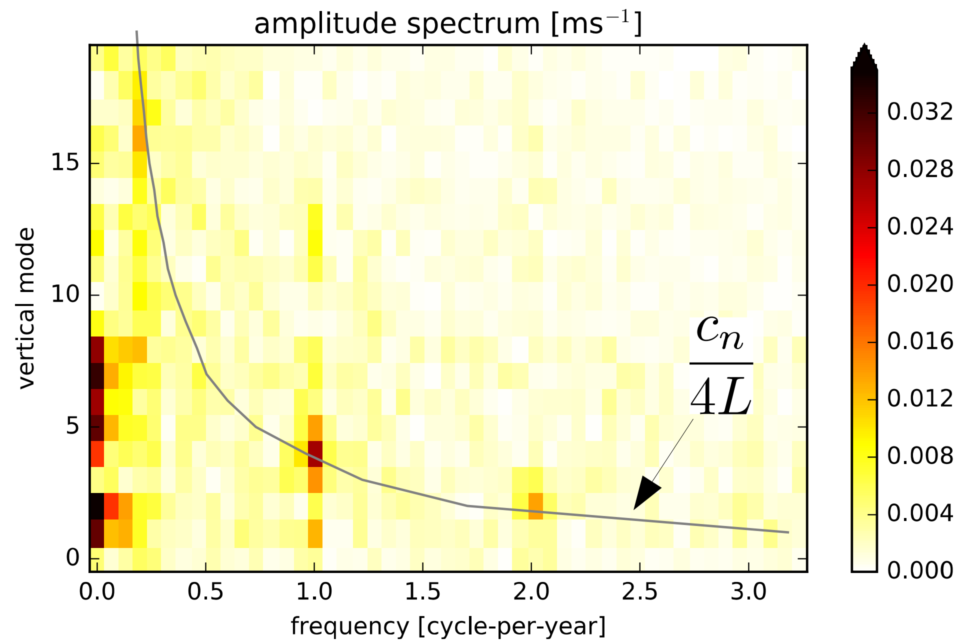
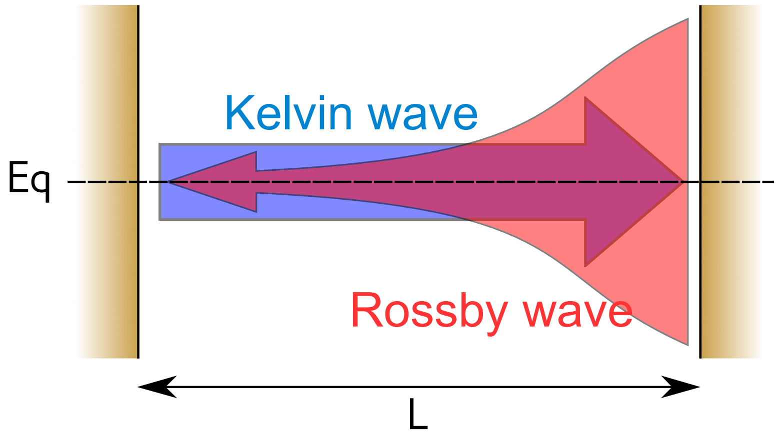
Zonal velocity at 0°N, 23°W

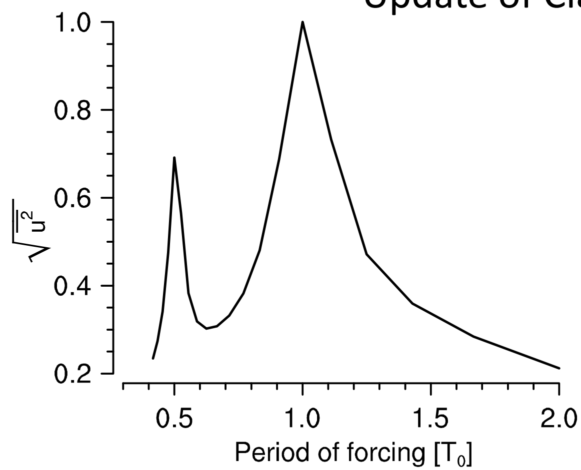






Cane & Moore (1981)

Update of Claus et al. (2016)



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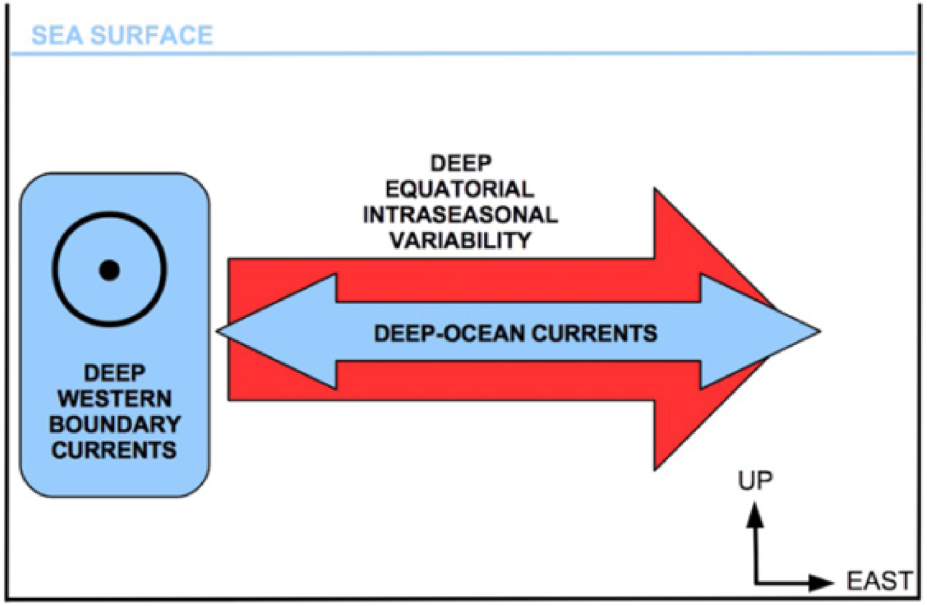
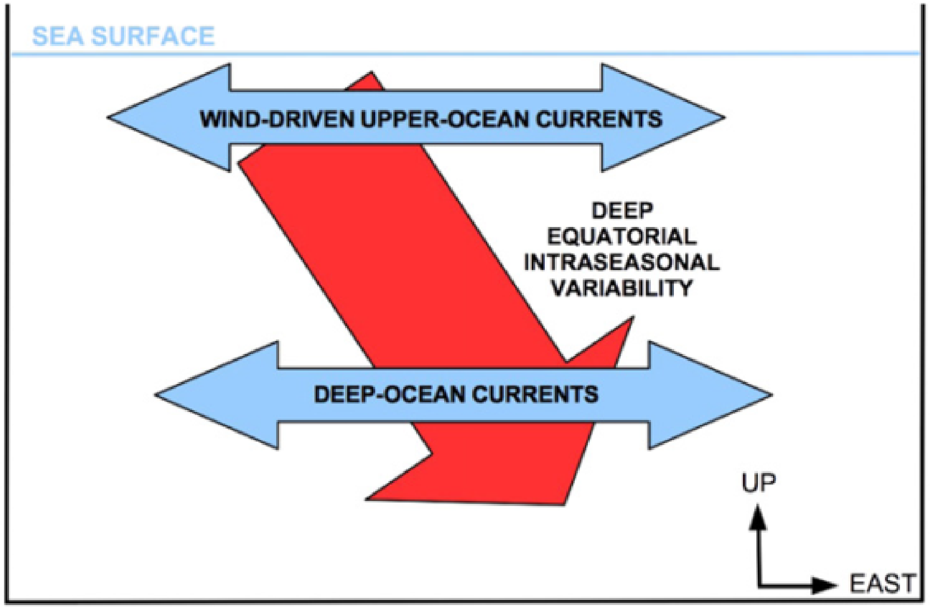
Proposed driving mechanisms of the EDJs

Rectification of intra-seasonal variability generated by fluctuations of the DWBC



D'Orgeville et al. (2007); Hua et al. (2008)

Non-linear interaction of intra-seasonal variability generated by the instability of the surface circulation



Ascani et al. (2015)

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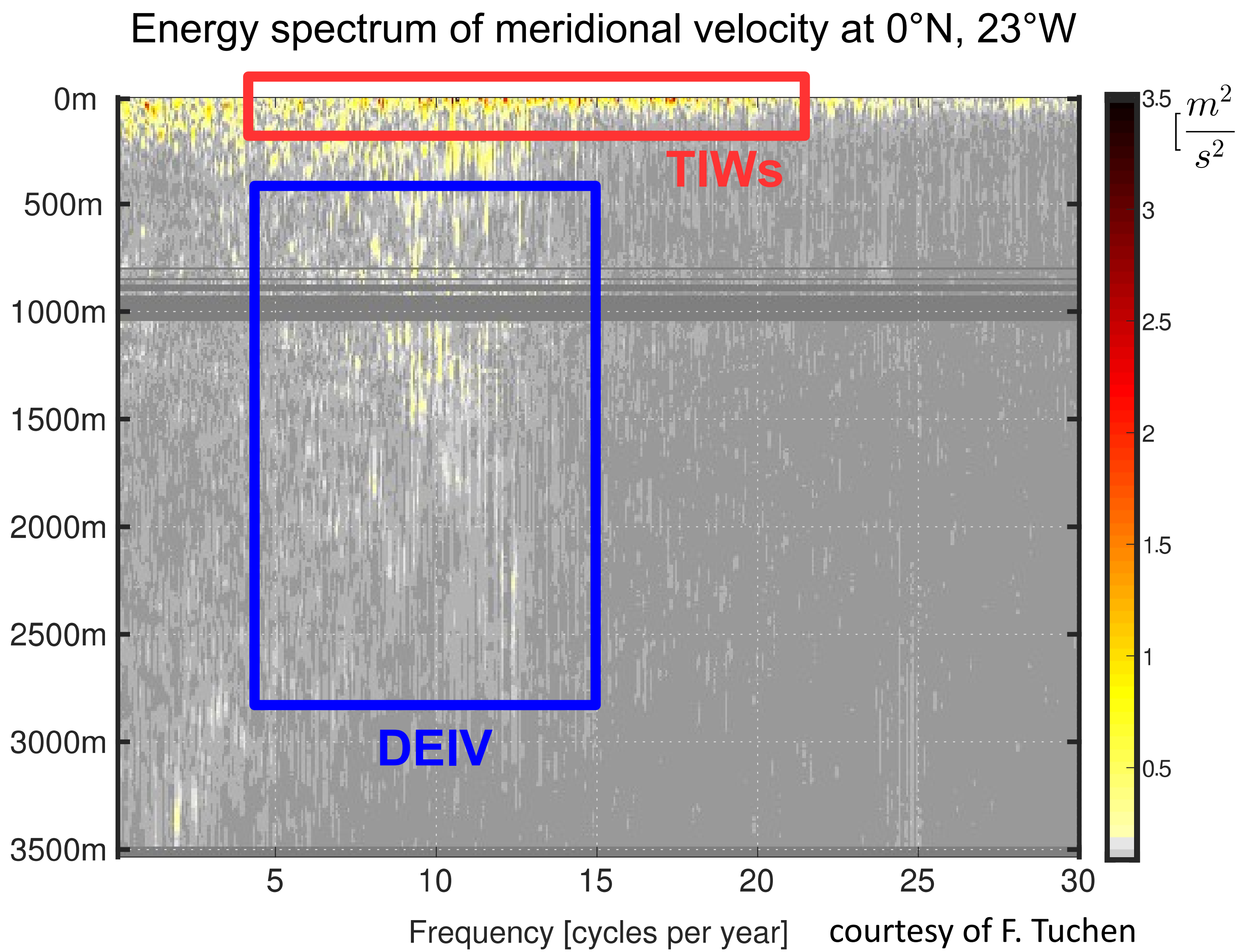
Intra-seasonal variability



courtesy of F. Tuchen

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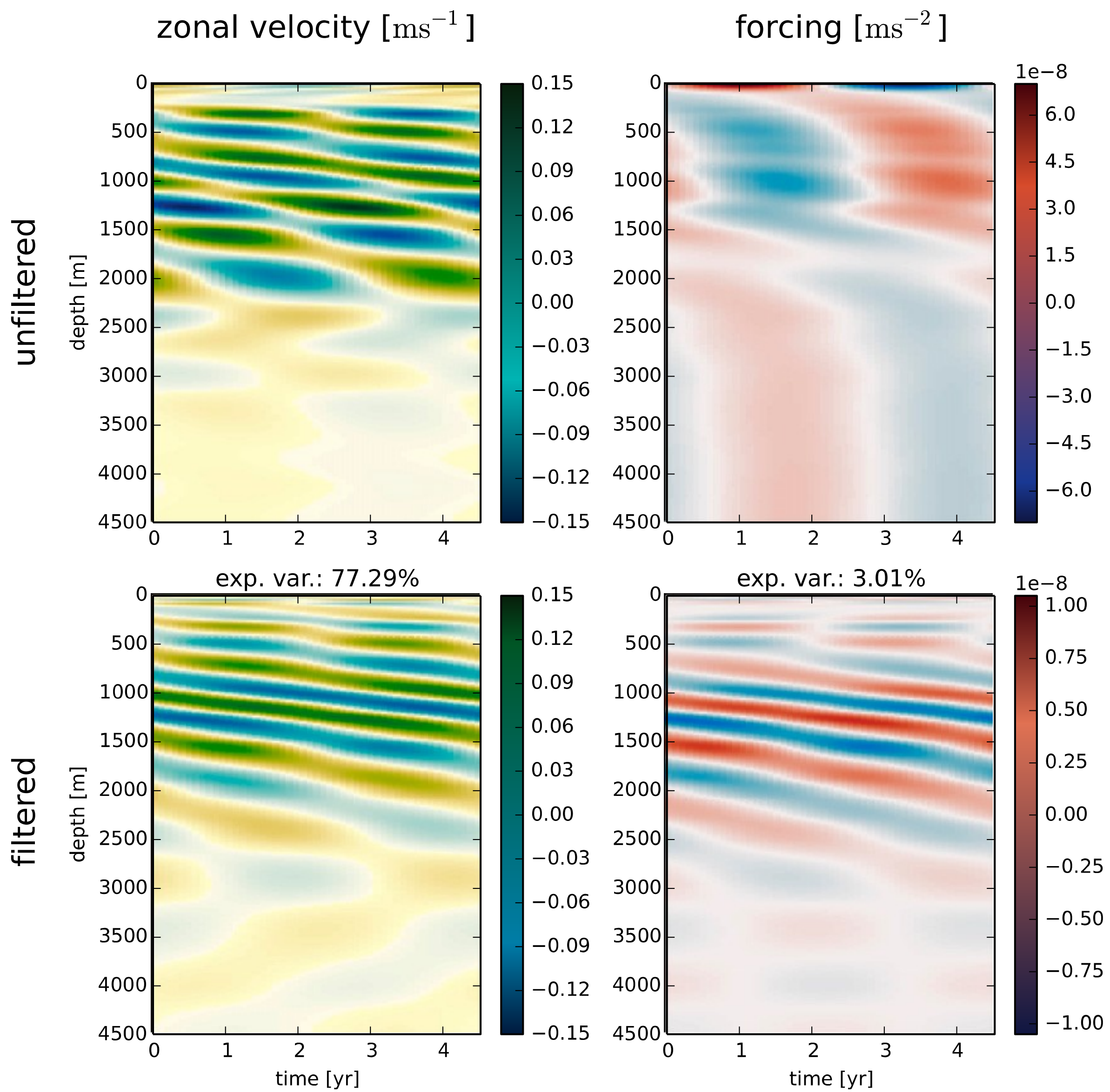
Reconstructed forcing of the EDJs



All vertical modes

Vertical modes 13 to 23

Claus et al. (2016)

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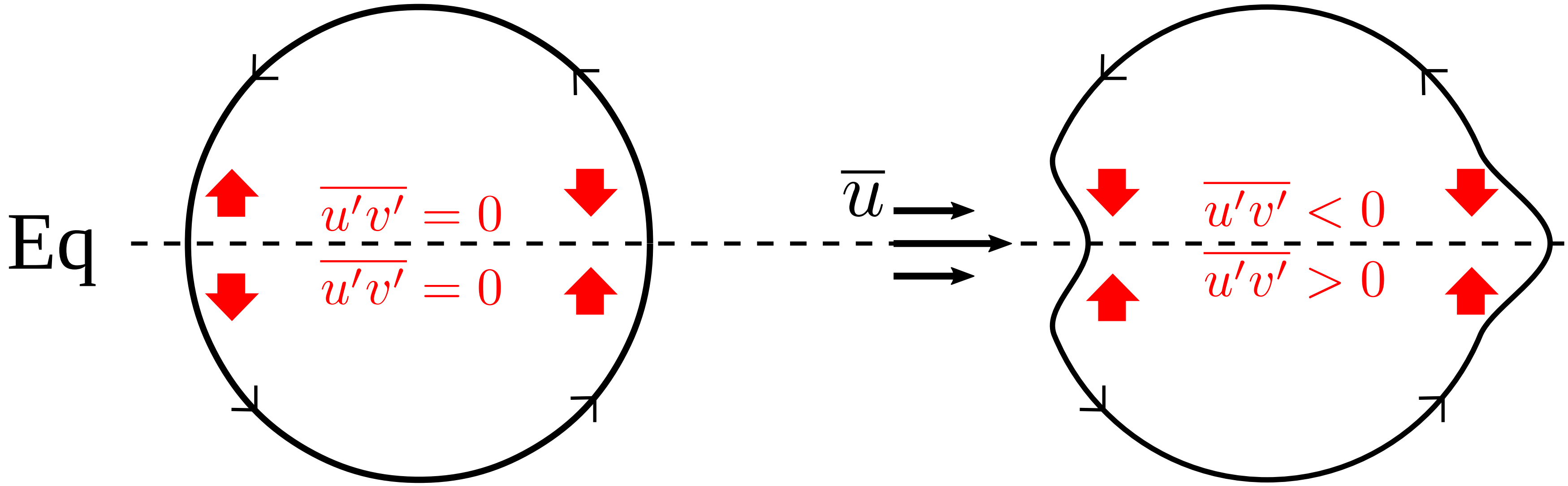
Reynolds-averaged momentum equations



$$\overline{u}_t - f\overline{v} = -\rho_0^{-1}\overline{p}_x - \frac{\partial \overline{u}\ \overline{u}_j}{\partial x_j} - \overline{u'u'}_x - \overline{u'v'}_y - \overline{u'w'}_z$$

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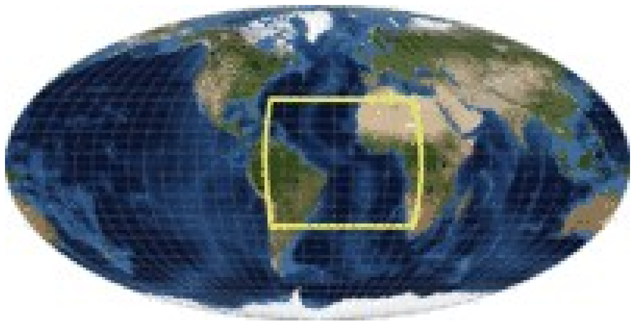
Data and model output

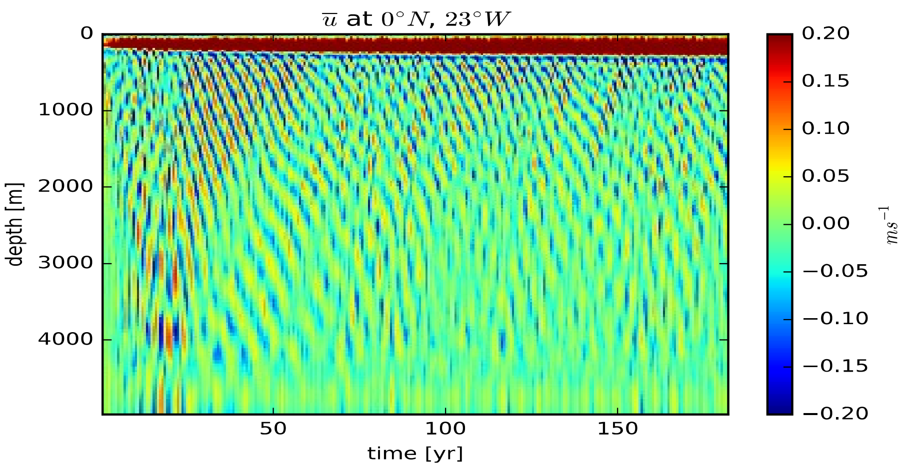
- TRATL01
  - NEMO gcm driven by CORE2 forcing
  - 1/10° tropical Atlantic nested in 0.25° global ocean

    → seasonal cycle but no EDJs



- BOX model
  - 0.25° MITgcm driven by zonally uniform constant windstress
  - high vertical resolution (L200), flat bottom

    → EDJs but no seasonal cycle



- Mooring data
  - 3 moorings at 23°W: 0°45’N, 0°N 0°45’S
  - measurements down to 3500 m

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Method

- Starting point

$$\overline{u}_t - f\overline{v} = -\rho_0^{-1}\overline{p}_x - \frac{\partial \overline{u}\ \overline{u}_j}{\partial x_j} - \overline{u'u'}_x - \overline{u'v'}_y - \overline{u'w'}_z$$

- Reynolds decomposition

$$u = \overline{u} + u' + u_0 \qquad \overline{u}: \text{ 70 day low-pass filtered}$$

- Regress the meridional divergence of intra-seasonal momentum flux convergence onto $\overline{u}$

$$(u'v')_y = s\overline{u} + c$$

If s < 0, the intra-seasonal momentum flux convergence maintains $\overline{u}$

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Observations at 23°W

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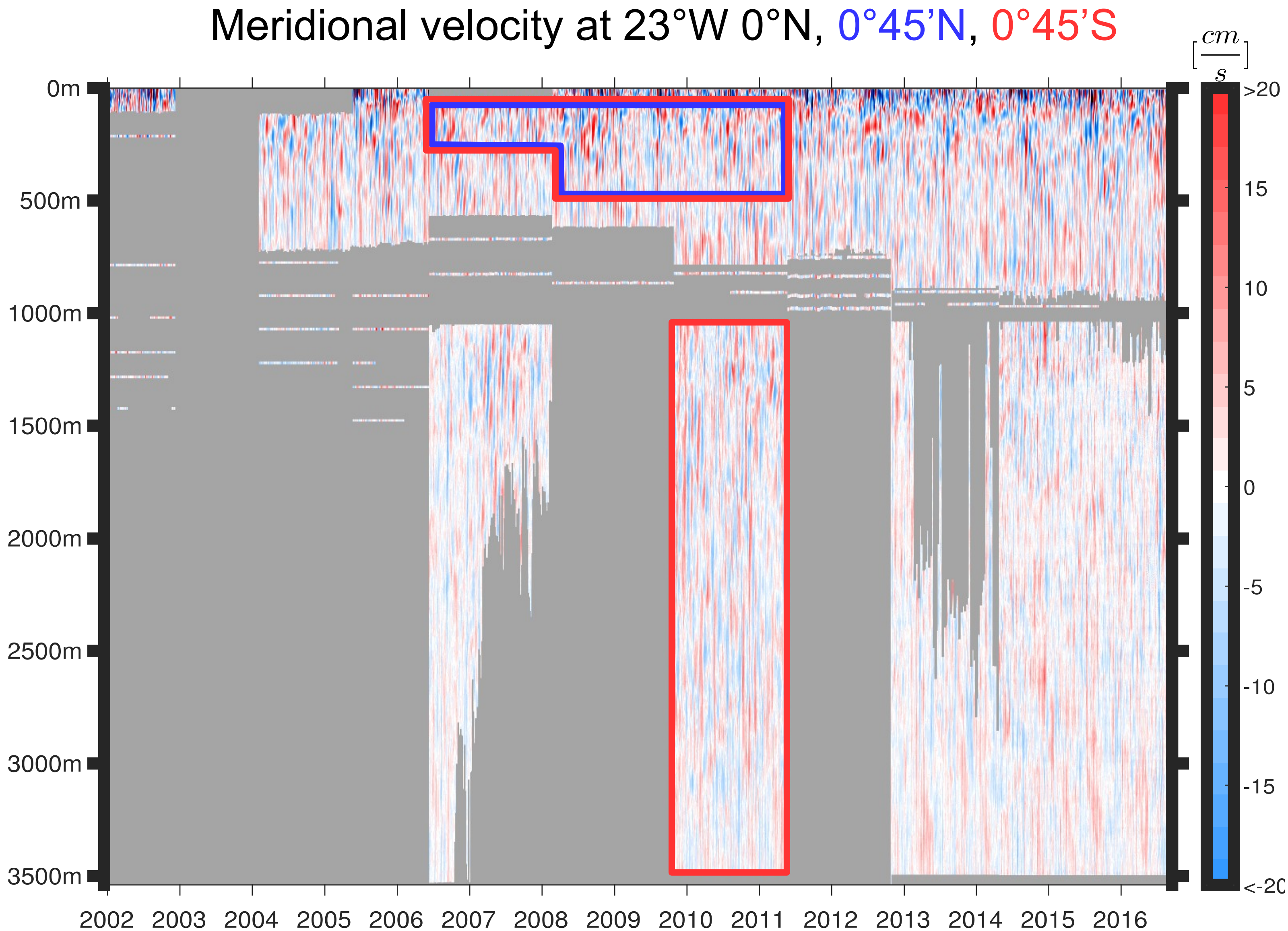

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Seasonal cycle of intra-seasonal meridional kinetic energy

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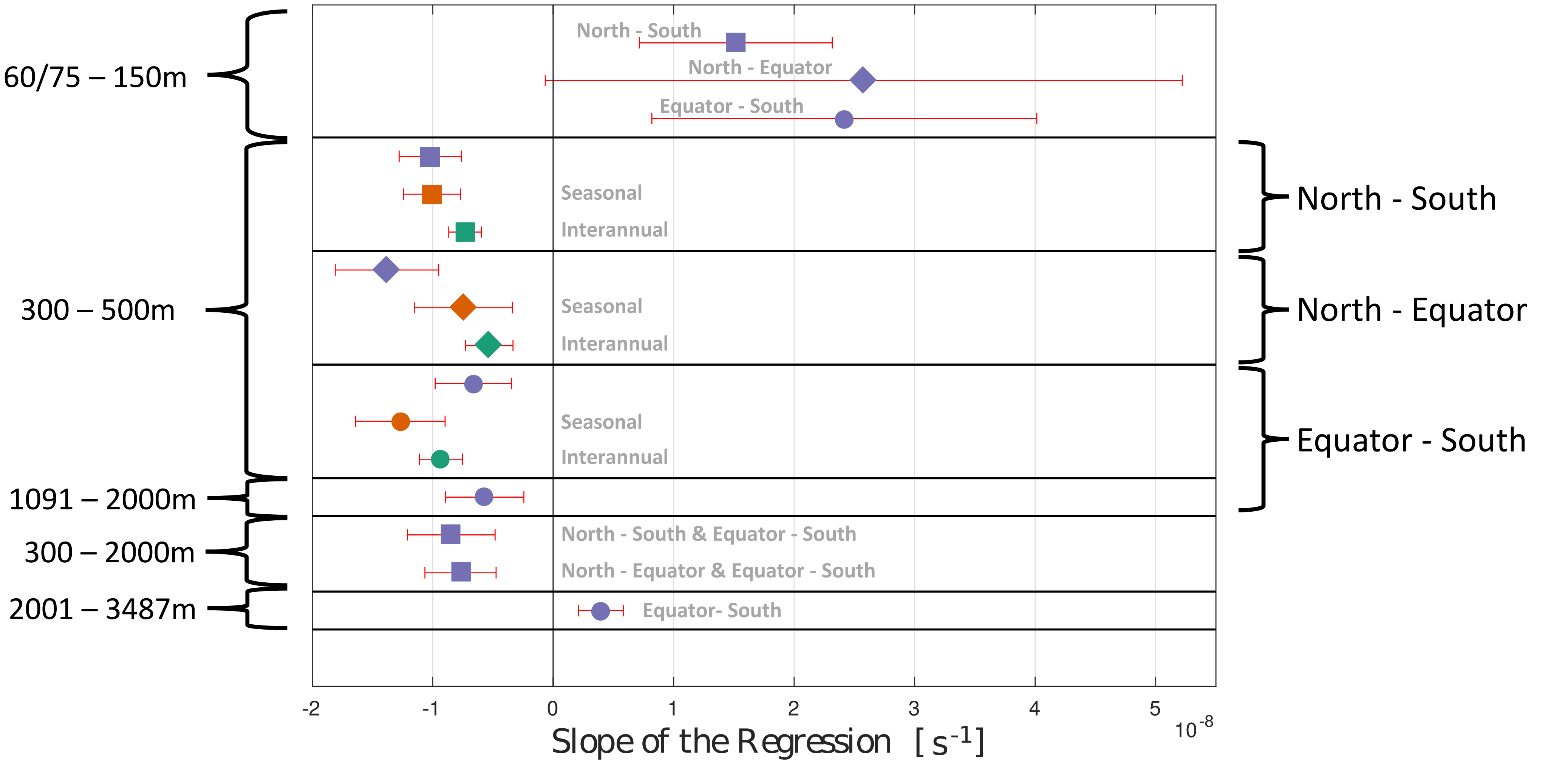

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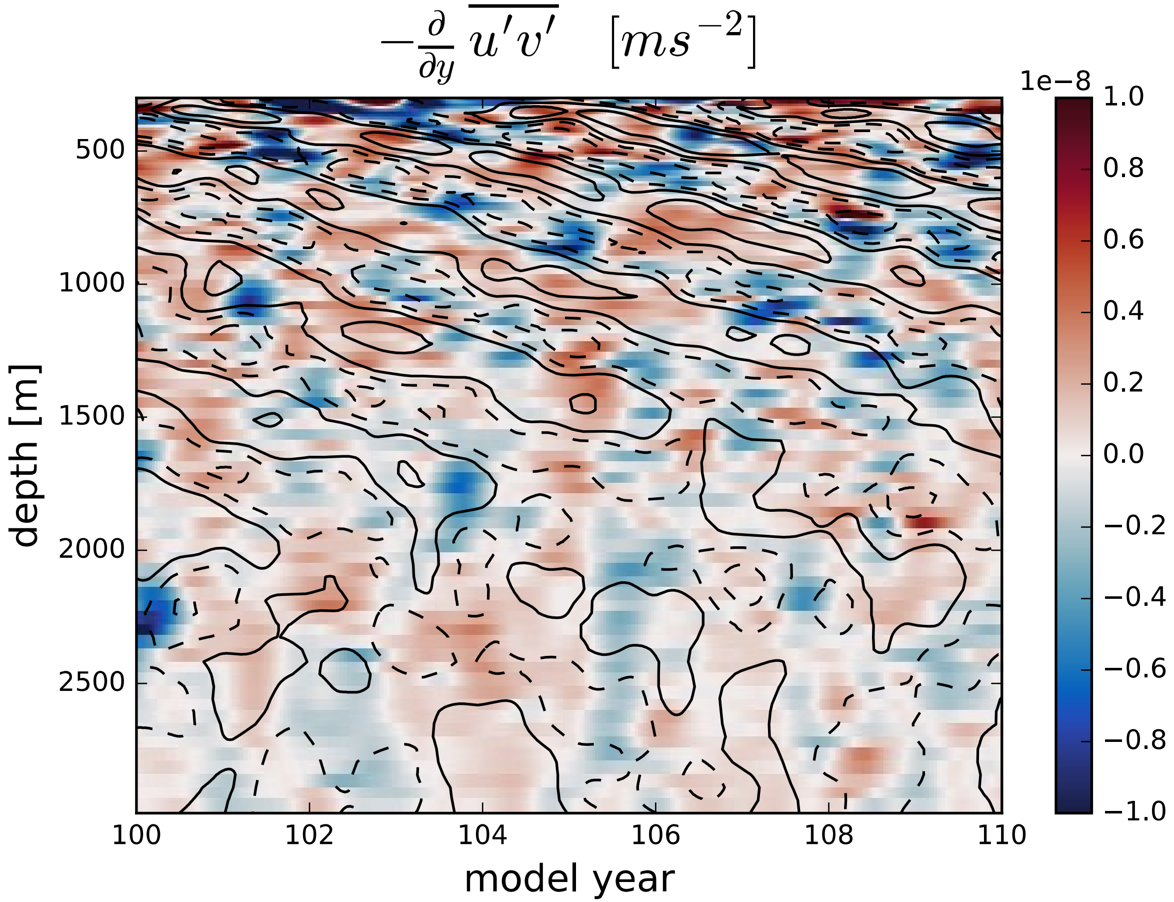
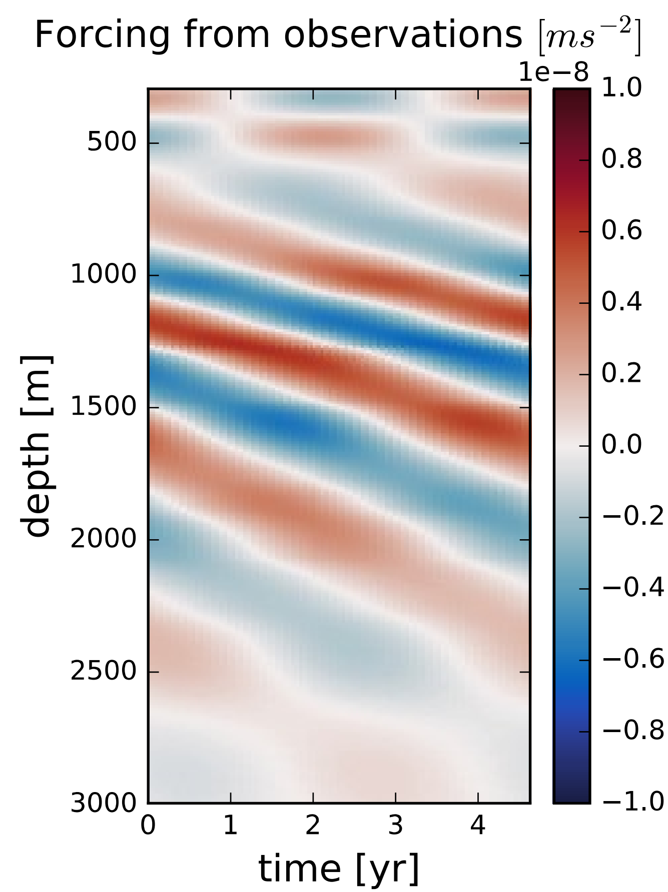
Convergence of the intra-seasonal momentum flux in the BOX model





Update of Claus et al. (2016)

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Intra-seasonal Reynolds stress

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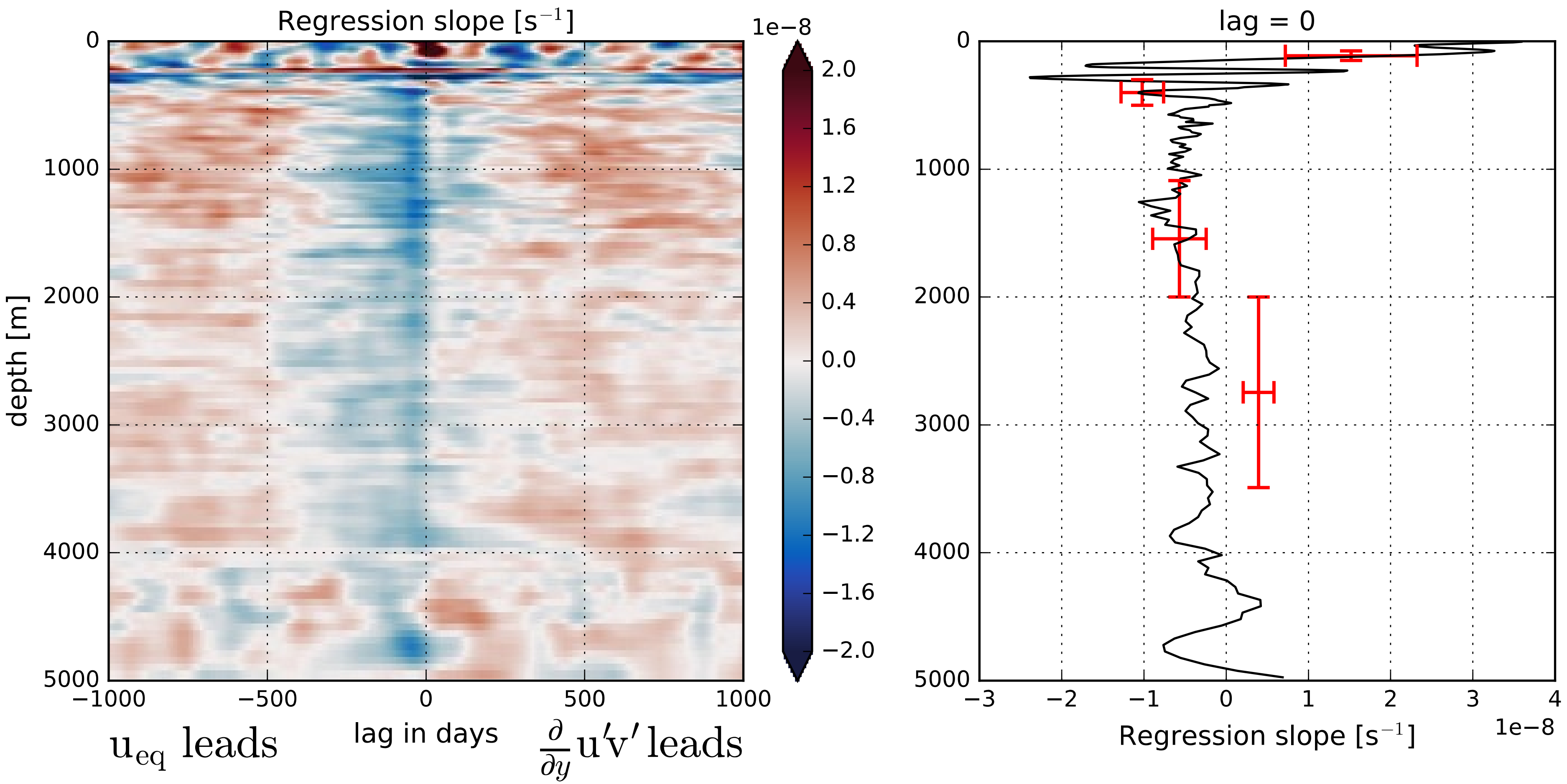

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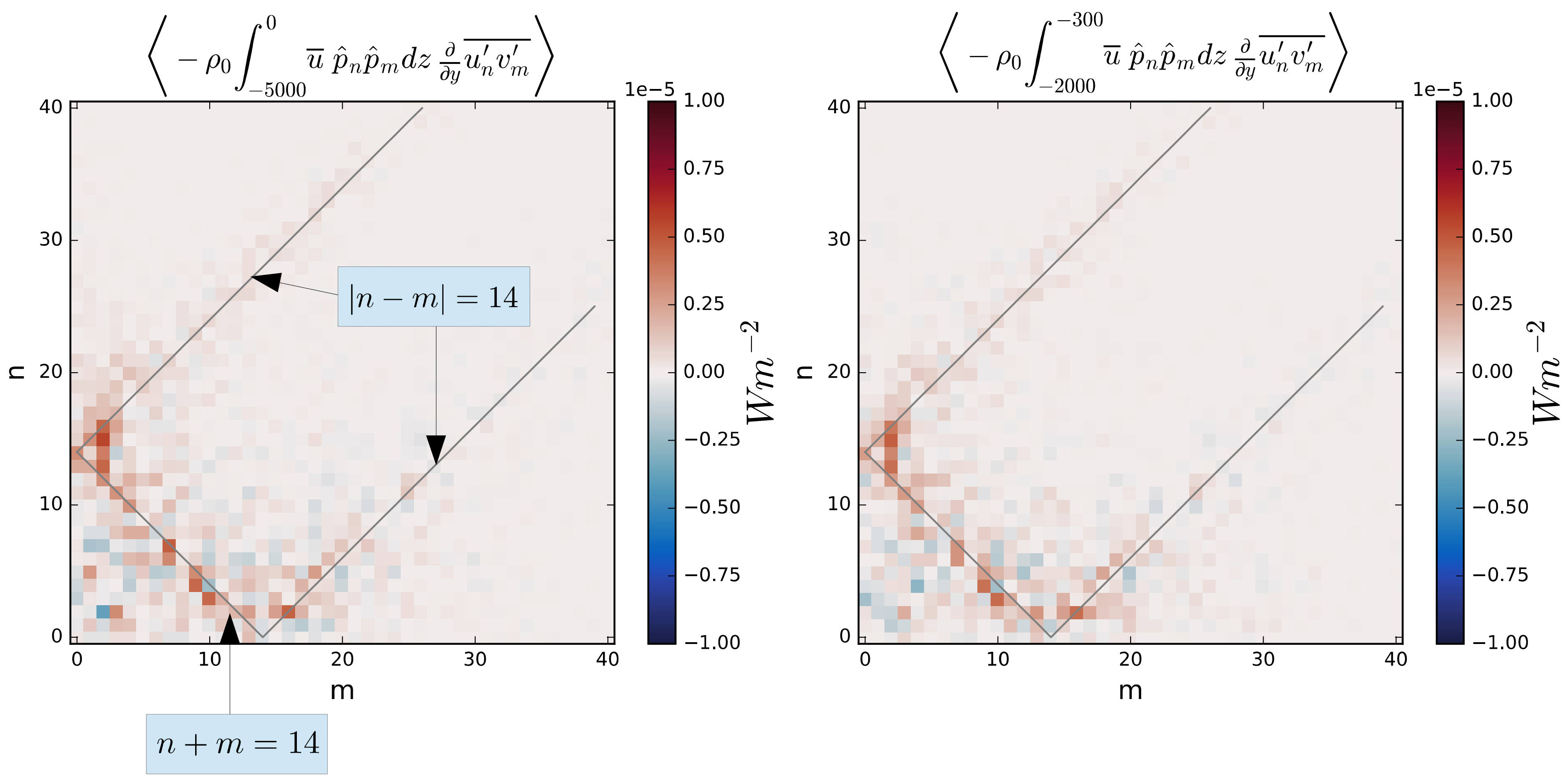
Modal decomposition of power input

$$-\int_{-H}^{0} dz \rho_0 \overline{u} \overline{(u'v')}_y = -\rho_0 \sum_n \sum_m \overline{(u'_n v'_m)}_y \int_{-H}^{0} dz \overline{u} \hat{p}_n \hat{p}_m$$



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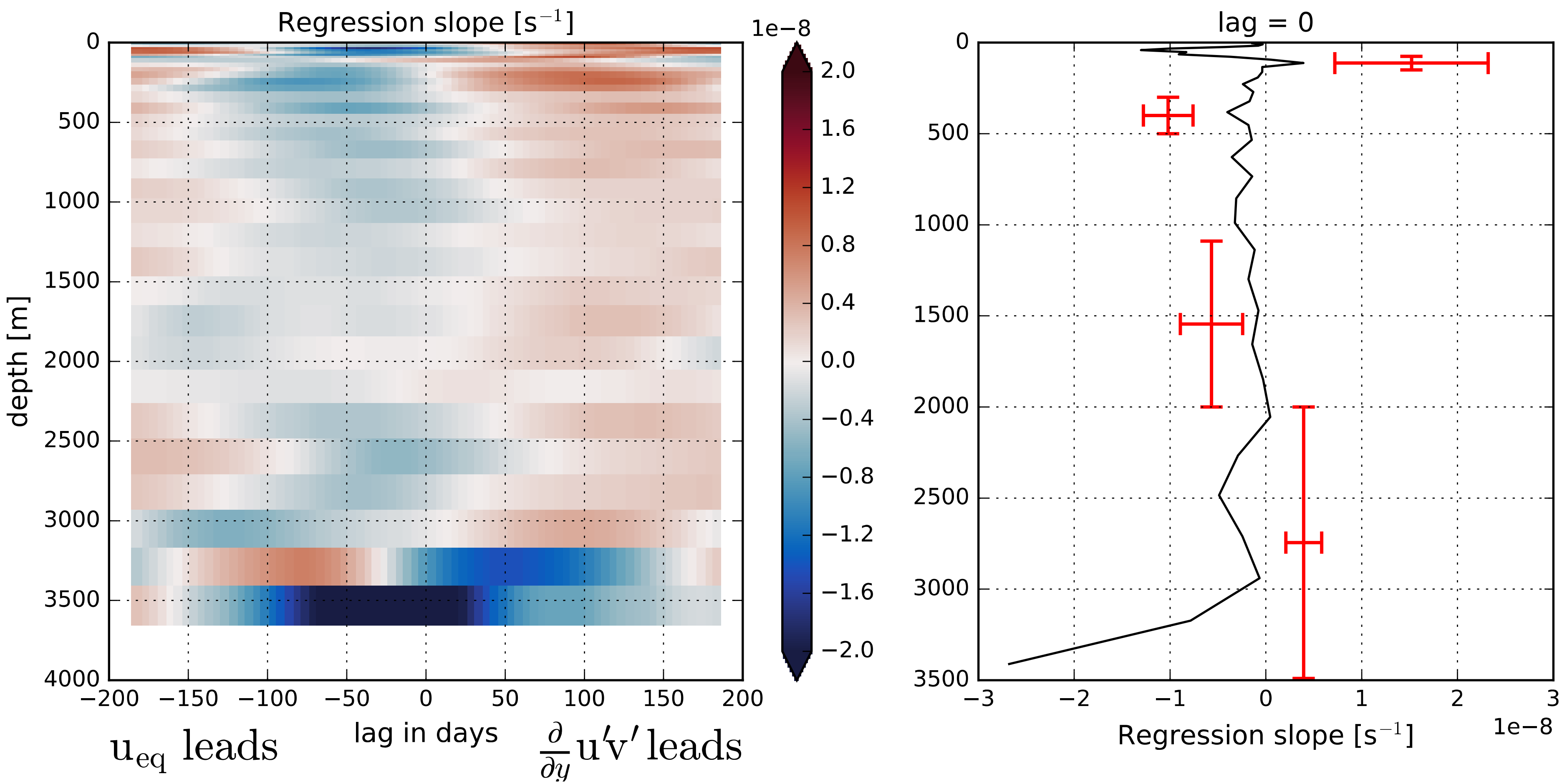
Regression of intra-seasonal momentum flux divergence in TRATL01



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Summary

- Equatorial basin mode resonance is an important feature of the equatorial ocean variability
- EDJs and the seasonal cycle are maintained against dissipation over a considerable depth range
- The convergence of the meridional flux of intra-seasonal zonal momentum maintains the lower frequency variability

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